MYLEX
MOVING DATA ▸ SMARTER

AcceleRAID™ Installation Guide

AcceleRAID 170
PCI to Ultra 160 SCSI
RAID Controller

MYLEX®

MOVING DATA ► SMARTER
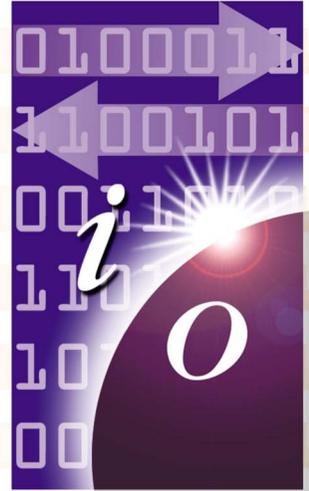
AcceleRAID™ 170
PCI to Ultra 160 SCSI
RAID Controller
Installation Guide

Part Number 775064-01
08P4093

Greetings

Thank you for purchasing the Mylex AcceleRAID™ 170 disk array controller. Requests for technical information about this and other Mylex Corporation products should be made to your Mylex authorized reseller or Mylex marketing representative.

Please Notice

IBM, Mylex, AcceleRAID, Global Array Manager (GAM), and RAID EzAssist are trademarks or registered trademarks of International Business Machines Corp. and its subsidiaries. Microsoft, MS-DOS, Windows 95, Windows 98, Windows NT, and Windows 2000 are registered trademarks of Microsoft Corporation. Novell and NetWare are a registered trademarks of Novell Corporation. SCO and UnixWare are registered trademarks of Santa Cruz Operations. Other names that are trademarks may be used herein for the purpose of identifying the products or services of their respective owners.

Unless otherwise noted, companies, names and data used in examples herein are fictitious.

Our Policy

Although reasonable efforts have been made to assure the accuracy of the information contained herein, this publication could include technical inaccuracies or typographical errors. Mylex Corporation expressly disclaims liability for any error in this information, and for damages, whether direct, indirect, special, exemplary, consequential or otherwise, that may result from such error, including but not limited to loss of profits resulting from the use or misuse of the manual or information contained therein (even if Mylex Corporation has been advised of the possibility of such damages). Any questions or comments regarding this document or its contents should be addressed to Mylex Corporation at the address shown on the back cover.

The following paragraph does not apply to the United Kingdom or any country where such provisions are inconsistent with local law:

MYLEX CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Some states do not allow disclaimer of express or implied warranties or the limitation or exclusion of liability for indirect, special, exemplary, incidental or consequential damages in certain transactions; therefore, this statement may not apply to you. Also, you may have other rights which vary from jurisdiction to jurisdiction.

Information in this publication is subject to change without notice and does not represent a commitment on the part of Mylex Corporation. Changes may be made periodically to the information herein; these changes will be incorporated in new editions of the publication. Mylex Corporation reserves the right to make improvements and/or changes at any time in the product(s) and/or program(s) described in this publication.

It is possible that this publication may contain reference to, or information about, Mylex Corporation products (machines and programs), programming or services that are not announced in your country. Such references or information must not be construed to mean that Mylex Corporation intends to announce, provide, or make available such Mylex products, programming, or services in your jurisdiction.

About This Manual

This installation guide covers hardware set-up and configuration procedures necessary for the installation of a Mylex AcceleRAID 170 single channel RAID controller.

Chapter 1 describes the controller, standard package contents, and user-supplied items necessary for installation.

Chapter 2 describes the steps to be performed prior to controller installation and the physical installation of the AcceleRAID 170 single channel RAID controller.

Chapter 3 describes controller start-up and the BIOS options.

Appendix A provides hardware and environmental specifications.

Appendix B describes error messages and problem correction.

Appendix C describes the PCI Hot Plug feature.

Appendix D provides enclosure management information.

Appendix E provides regulatory agency information.

Conventions

Throughout the manual, the following conventions are used to describe user interaction with the product:

prompt   This style of type indicates screen display messages

Enter   Press the key labeled "Enter" (or "Delete," etc.)

☛ **Note**

Supplementary information that can have an effect on system performance

⚠ *Caution*

Notification that a proscribed action has the *potential* to adversely affect equipment operation, system performance, or data integrity

🛑 **WARNING**

Notification that a proscribed action will *definitely* result in equipment damage, data loss, or personal injury

Contents

Chapter 3
Controller Start-up

Appendix A
AcceleRAID 170 Specifications

Appendix B
AcceleRAID 170 Error Messages

Appendix C
PCI Hot Plug

Appendix D
Enclosure Management

Appendix E
Regulatory Information

Glossary

This chapter describes:

- **The AcceleRAID™ 170 controller**
- **Standard package contents**
- **User supplied items**

Figure 1-1. AcceleRAID 170 Controller

Product Description

The Mylex AcceleRAID 170 controller is a PCI to Ultra 160 SCSI single channel RAID controller with 32-bit, 33MHz PCI capability. The AcceleRAID 170 supports one external connector and one internal Ultra 160 SCSI connector. The AcceleRAID 170 controller provides the speed and functionality required by high demand server platforms. AcceleRAID 170 achieves performance breakthroughs in PCI technology, eliminates storage bottlenecks, and delivers scalable performance. Enclosure management and PCI Hot Plug are standard features.

Controller Features

Features of the AcceleRAID 170 controller include:

- One QLogic ISP 10160A chip to support one Ultra 160 SCSI LVD channel
- Intel i960RM RISC processor operating at 100MHz
- 32MB, 64MB, and 128MB ECC cache DIMM module
- PCI 2.2 compliant
- 1MB, 8-bit flash EEPROM for BIOS and code
- Built-in configuration utilities (in BIOS)
- Write-through and write-back cache support
- PCI Hotplug capability allows the AcceleRAID 170 to be swapped with a replacement without powering down the system

⚠ *Caution*

Be sure the motherboard you are using supports PCI Hotplug before attempting to use this feature, or serious damage to the controller and/or the motherboard could result. (The motherboard must be PCI 2.2 compliant if using PCI Hot Plug.)

Channel Capabilities

15 Ultra 160 SCSI devices per channel

Controller Capabilities

- 15 physical drives in the drive group (array)
- 32 total logical drives on the controller
- Supports RAID levels 0, 1, 0+1, 3, 5, 10, 30, 50, and JBOD

Operating System Support

MS-DOS 5.x, 6.x, and above are supported using drivers that reside in the AcceleRAID BIOS. Many drivers in the Disk Array Controller Software Kit, included with the AcceleRAID 170 controller, support many other popular operating systems (see the *PCI Disk Array Controller Drivers Installation Guide and User Manual*).

Standard Package Contents

The following items are supplied with the standard shipping package:

Hardware

- AcceleRAID 170 Disk Array Controller with documentation included on the CD-ROM and a printed Quick Installation Guide

- Standard DIMM Module: 32MB, 64MB, or 128MB (ECC)

Software

- On-board RAID EzAssist disk array controller configuration utility with documentation on CD-ROM and a printed Quick Configuration Guide

- Software Kit Driver diskettes with documentation on CD-ROM and a printed PCI Drivers Installation Guide

- Global Array Manager (GAM) Server and Client software and documentation on CD-ROM

AcceleRAID 170 PCI to Ultra 160 SCSI RAID Controller
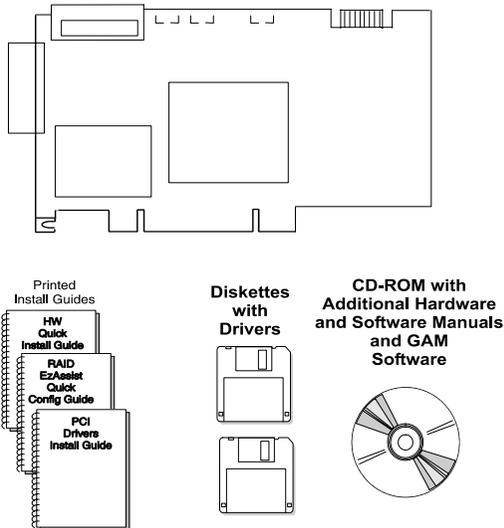
Figure 1-2. Standard Package Contents

User-supplied Items

The following user-supplied items are required to perform this installation:

- IBM-PC™ compatible host system with PCI slot (PCI 2.2 compliant)

- Network operating system software (as required)

- SCSI cables to connect the controller and disk arrays

- Static grounding strap or electrostatic discharge (ESD) safe work area

- Disk array enclosure (or equivalent) with SCSI disk drives

Chapter 2
Installation

This chapter describes:

- **Before You Begin**
- **Safety Considerations**
- **Installation Checklist**
- **Connectors, LEDs, Jumpers**
- **Installation Process (controller)**
- **SCSI Termination**
- **SCSI IDs**
- **SCSI Cabling**
- **Limitations on Mixing SCSI Drives**

Mylex disk array controllers are designed to work in a variety of SCSI RAID application environments. Certain configuration steps need to be performed prior to installing the controller into a RAID environment. Each of the steps described in this chapter are part of the installation process.

Before You Begin

Installing the AcceleRAID 170 single channel RAID controller is no more difficult than installing any 32-bit PCI adapter controller. The AcceleRAID 170 single channel controller connects into any PCI 2.2 compliant slot on the motherboard. Follow these steps and the installation procedures in this chapter.

☞ **Note**

> Recommended: Connect the AcceleRAID 170 into a 32-bit PCI slot to reserve the 64-bit PCI slot for 64-bit controllers (although the AcceleRAID 170 will work in a 64-bit slot).

🛑 **WARNING**

> **Working with the system covers off and power applied to the system can result in shock and serious injury.**

1. Power off the system and disconnect the power cables before starting the installation. Refer to the instructions provided in your system documentation. Do not disconnect cables or power cords while system power is on.

2. Read all of the instructions in this chapter completely before proceeding. Follow the Notes, Cautions, and Warnings described in this manual and marked on the equipment.

3. Follow electrostatic discharge (ESD) safety procedures. Use a grounded wrist strap or ESD safe footwear, and work in an ESD safe area.

4. Perform a safety check of the installation before powering on the system.
   • Make sure that the cabling Pin 1 location is correct and that all cables are firmly seated in the connectors.
   • Make sure all SCSI conventions (cable type, cable length, termination, etc.) are correct, see Table 2-3 on page 2-15.

Safety Considerations

Be sure to observe the following precautions before beginning the controller installation procedure:

⚠ *Caution*

Anti-static handling procedures are required. Leave the controller in its anti-static bag until it is time to plug the controller into the PCI slot. The use of a grounded wrist strap and other ESD protective measures are highly recommended.

🛑 **WARNING**

Disconnect the system from the electrical wall outlet before opening the system cabinet. Working with the system covers off and power applied to the system can result in shock and serious injury.

Installation Checklist

GET READY

☞ **Note**

> It is recommended that you wear a grounded wrist
> strap when performing hardware installation
> procedures.

1. ____ Power off your computer system.
2. ____ Decide which available PCI slot will be used.
3. ____ Remove the plate from the I/O access port to the PCI slot.
4. ____ Remove the AcceleRAID 170 controller from the anti-static bag.

GET SET

☞ **Note**

> Review Figure 2-1, Figure 2-2, and Figure 2-3;
> Table 2-1 and Table 2-2 to get familiar with the layout
> of the AcceleRAID 170 controller and the
> Connectors, Jumpers, and LED descriptions.

5. ____ Plug the AcceleRAID 170 controller into a standard PCI 2.2 compliant slot.
6. ____ Secure the AcceleRAID 170 controller's mounting bracket with a screw or retainer.
7. ____ Connect the SCSI cable(s) from your drive(s) and/or device(s) to the SCSI channel.
8. ____ Check SCSI termination for internal and/or external devices.
9. ____ Check disk drives. Be sure termination is set to the *disabled* position on any disk drive(s) that will not be terminated. For more information, see the documentation that accompanied the disk drives.
10. ____ Set SCSI ID on the disk drive(s).
11. ____ Enable termination power on disk drive(s).
12. ____ Safety check the installation.

GO

13. ____ Go to Chapter 3, Controller Start-up.

Connectors, LEDs, and Jumpers

There is one external and one internal Ultra 160 SCSI connector supported on the AcceleRAID 170 controller as shown in Figure 2-1, and labeled as CH 0.

The AcceleRAID 170 controller has three LEDs on the front side as shown in Figure 2-2 and described in Table 2-1. The LEDs indicate SE (single ended), LVD, and FAIL modes.

SCSI jumpers should normally be set to their default settings, no adjustments are needed. Default jumper locations are shown in Figure 2-3 and are described in Table 2-2.

When you have checked the termination requirements, completed the connections of your desired SCSI devices, and other possible devices such as a CD-ROM drive or a tape drive, close your system with the cover.

PCI Hotplug

☛ **Note**

Please see Appendix C for information on how to implement the Hotplug feature for your system's requirements.
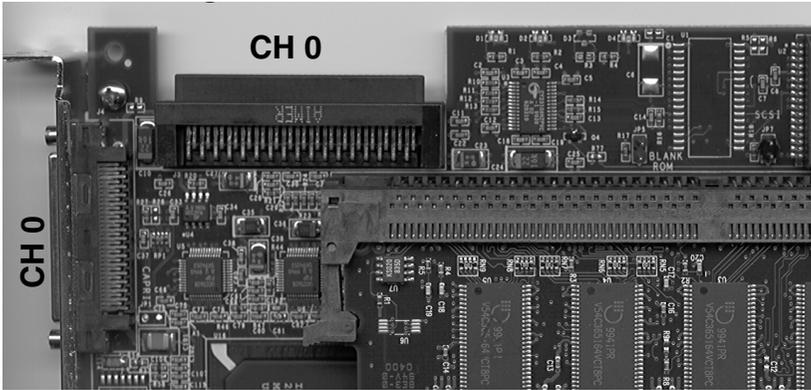
Figure 2-1. AcceleRAID 170 Controller Channel Connectors
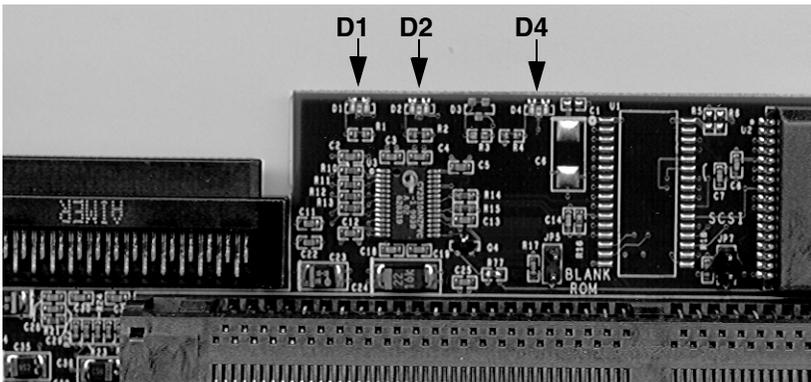
Figure 2-2. AcceleRAID 170 LEDs

Table 2-1. LED Descriptions

D1	SE (Single Ended)
D2	LVD (Low Voltage Differential)
D4	Fail (Processor Self Test)
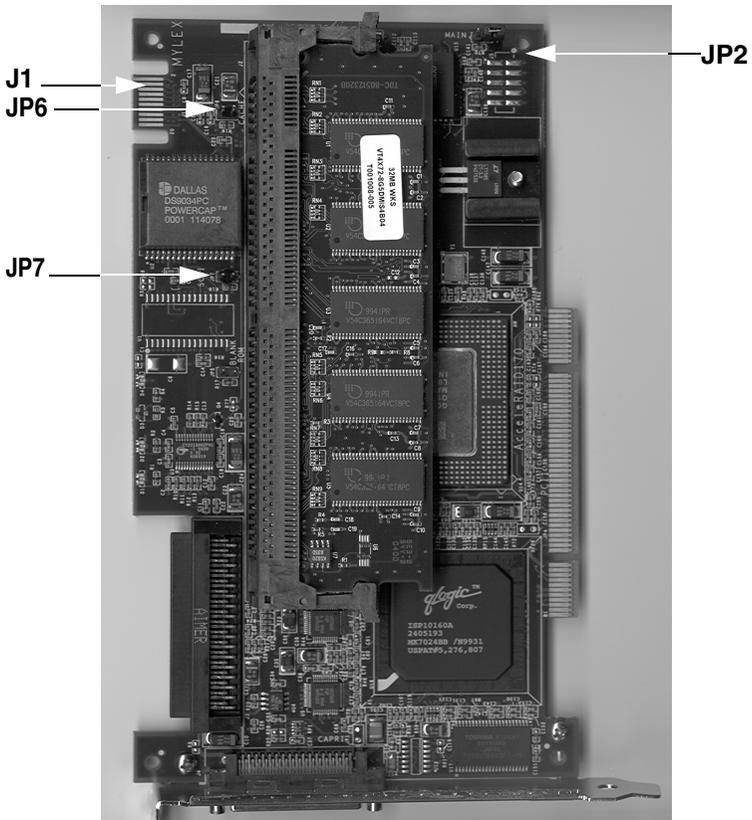
Figure 2-3. AcceleRAID 170 Jumper Locations

Table 2-2. AcceleRAID 170 Jumper Descriptions

J1	Manufacturing test point
JP2	Maintenance mode
JP6	Cache dirty (monitor cache write back) — LED header
JP7	BSY (SCSI activity) — LED header

Installation Process

Installing the Controller

Follow these installation steps:

1. Choose any available 32-bit or 64-bit PCI slot as shown in Figure 2-4.

32 bit PCI slots

64 bit PCI slots
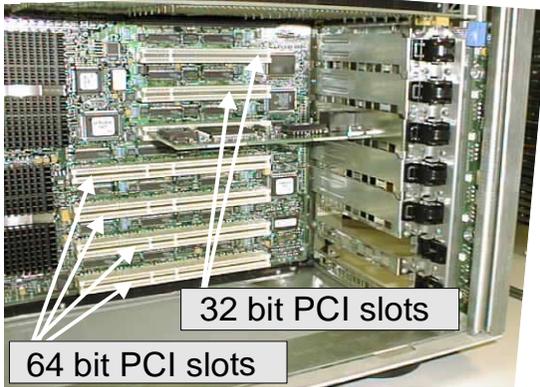
Figure 2-4. Choose an Available PCI Slot

2. Remove the metal cover plate from the slot's access port (at the back of the cabinet), usually by releasing the black clip as shown in Figure 2-5.

Remove the metal plate by releasing the black clip.
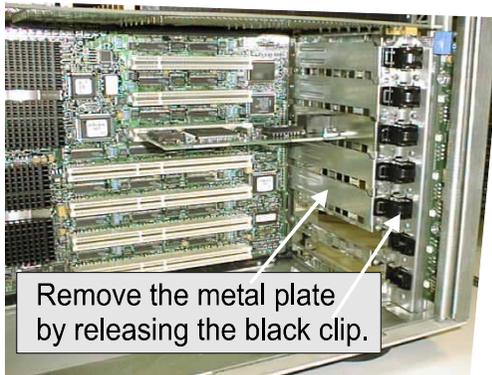
Figure 2-5. Remove the Metal Plate

⚠ *Caution*

> Be sure to wear a ground wrist strap at all times.

3. Handling the AcceleRAID 170 controller by the edges, remove it from the anti-static bag as shown in Figure 2-6.

Ground wrist strap
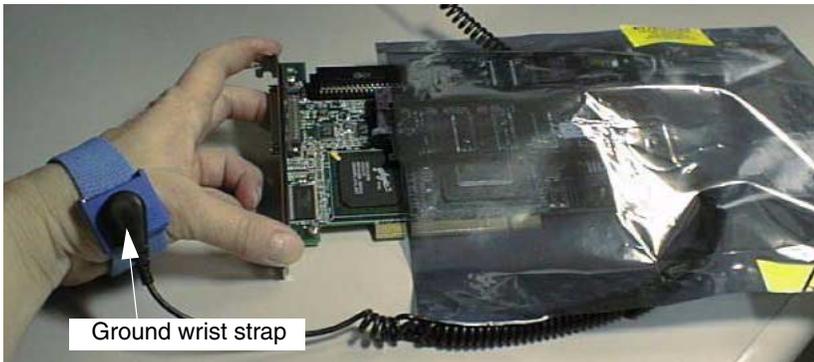
Figure 2-6. Remove the Controller from the Anti-static Bag

4. Plug (install) the controller firmly into any 32-bit or 64-bit PCI slot as shown in Figure 2-7.

32-bit PCI slot

AcceleRAID 170

Ground wrist strap
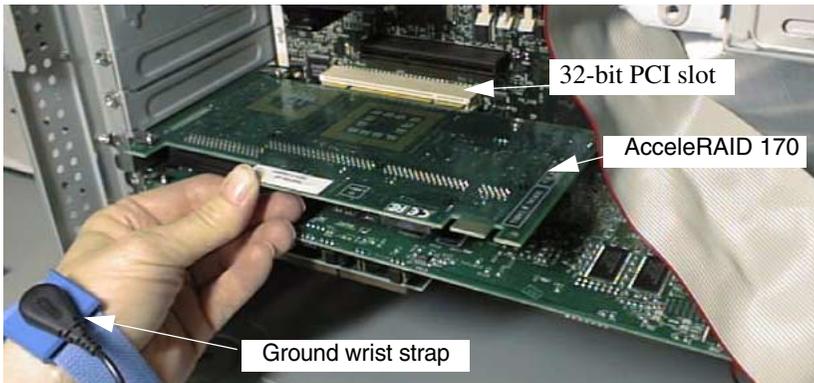
Figure 2-7. Plug the Controller into any 32-bit or 64-bit PCI Slot

Preparing the SCSI Drives

To prepare the drives for installation, follow these steps:

1. Remove any terminators attached to the drive or set any drive termination jumpers to the *disabled* position.

2. Set the SCSI IDs on the drives.

3. Enable term power on the drives.

Refer to the drive manual for specific information about drive configuration settings.

Installing Cables and Setting Termination

Please refer to Table 2-3 on page 2-15 for SCSI Formats and Bus Length requirements.

4. Connect the SCSI cable from the internal disk drive to the SCSI connector on the AcceleRAID 170 controller as shown in Figure 2-8. (The controller is already connected to the system board.)
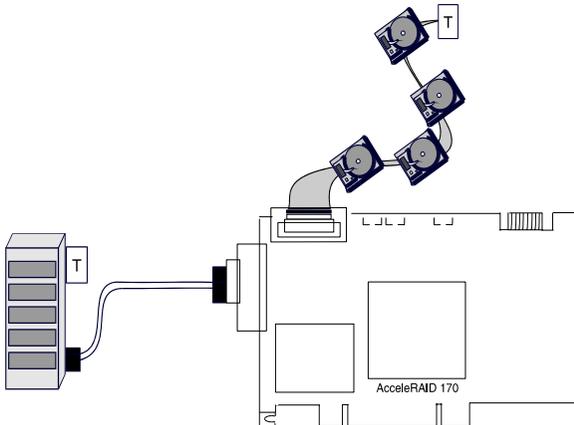
Figure 2-8. Connecting Disk Drives to the AcceleRAID 170

☛ **Note**

> In order to ensure an error free environment, the
> proper cable type designed for a certain SCSI
> speed must be used, please refer to Table 2-3 on page
> 2-15.

☛ **Note**

> To avoid problems caused by mixing drive types,
> please refer to "Limitations on Mixing SCSI Drives"
> on page 2-16.

SCSI Termination

Each end of a SCSI bus must be terminated to maintain proper voltage levels
for SCSI control and data signals. The device used for this purpose is called
a terminator. Termination devices can be built into a controller, a SCSI
device, or attached to the end of a SCSI bus.

The AcceleRAID 170 controller is equipped with automatic SCSI bus
termination circuitry. If the controller is at the end of a SCSI bus, it
automatically enables on-board termination. The controller can also detect
whether single-ended (SE) or low-voltage differential (LVD) termination is
required, and can automatically configure the appropriate termination type.

The end of the SCSI bus farthest from the controller must be terminated if
SCSI devices are connected to the SCSI channel. See Figure 2-9 for an
example of a SCSI device configuration connected to the internal SCSI
channel.

☛ **Note**

> When connecting SCSI devices, it is better to
> terminate the ends of the SCSI bus itself, rather than
> to terminate the end devices on the bus. This allows
> hot swap devices to be added or removed from the
> SCSI bus without affecting termination.

1. **Termination - Only Internal or Only External Devices**
   Check that the drive channel is properly terminated according to drawings below, or skip to Step 2 if using both internal and external devices.

   The AcceleRAID 170 is equipped with automatic SCSI termination circuitry which handles automatic enabling and disabling of on-board termination. For example, if the controller is at the end of the SCSI bus, it automatically *enables* on-board termination.

   If all the SCSI devices on a channel are **connected *either* to the internal connector *or* to the external connector,** the end of the SCSI bus farthest from the controller must have a terminator installed; the controller automatically *enables* on-board termination.
   See Figure 2-9 for an example of an internal drive configuration.
   See Figure 2-10 for an example of an external drive configuration.

Internal Drive Configuration
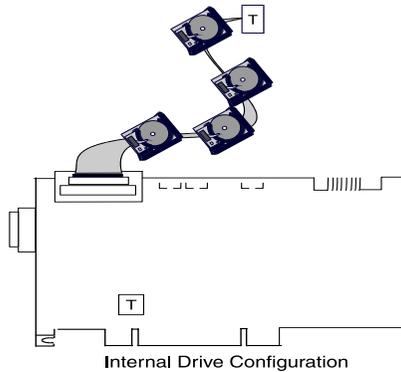
Figure 2-9. Termination with Internal Drive Configuration

External Drive Configuration
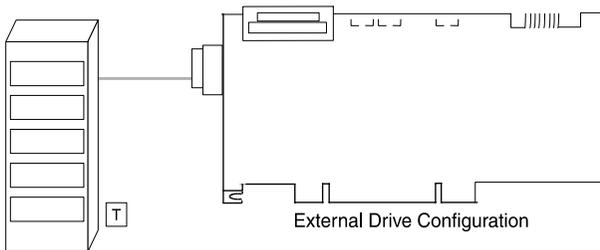
Figure 2-10. Termination with External Drive Configuration

2. **Termination - Both Internal and External Devices**
   Check that the drive channel is properly terminated according to the drawing below.

   If the controller is in the middle of the SCSI bus, it automatically *disables* on-board termination. If some SCSI devices on the channel are **connected to the internal connector,** *and* **some are connected to the external connector,** on the same channel, the two ends of the SCSI bus farthest from the controller must each be terminated.

   See Figure 2-11 for an example of a combined internal and external drive configuration. Notice that they are on the same channel.

   ☛ **Note**

   > It is better to terminate the ends of the SCSI bus itself than it is to terminate the end devices on the bus. This allows hot swap devices to be added or removed from the SCSI bus without affecting termination.

   ☛ **Note**

   > The only devices controlled by the RAID configuration are the ones physically connected to the AcceleRAID 170 controller.

CH0

Auto Termination Disabled

CH0

T

T
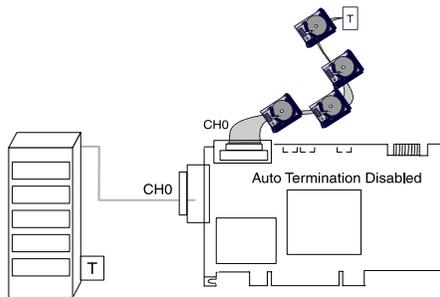
Internal – External Drive Configuration

Figure 2-11. Termination with Internal and External Drive Configuration

3. Remove or set disk drive termination jumpers to the *disabled* position (if needed). Refer to the documentation furnished with your disk drives to determine if your termination jumpers need to be adjusted.

Setting SCSI Device IDs

4. Set the SCSI ID on the disk drives; ID 7 is reserved for the controller. See Figure 2-12.

   ☛ **Note**

   Each drive must have a unique ID chosen from 0 through 6 or 8 through 15. Be careful not to duplicate a drive address.

   Remember: ID 7 is reserved for the controller; therefore, it cannot be used as a disk drive ID.

   ID's from 0 through 6 are usually for Narrow, 8-bit devices. However, the full range of SCSI ID addresses, 0 through 6 and 8 through 15 can be used for Wide, 16-bit devices.

   See your device documentation for instructions on how to set your particular disk drive's SCSI address.

SCSI ID Numbers

7   is reserved for the controller

0 1 2 3 4 5 6 = used for narrow or wide devices
8 9 10 11 12 13 14 15 = used only for wide devices

Figure 2-12. SCSI ID Numbers

SCSI Cabling

The controller supports one Ultra 160 SCSI channel which can support up to 15 SCSI devices (plus the controller itself).

LVD Mode

The controller supports Ultra 160 SCSI with LVD. If all drives attached to a controller drive channel support Ultra 160 SCSI with LVD, then that channel will operate at a maximum of 160MB/s burst speed. This setup allows a maximum SCSI bus length of up to 12 meters.

☛ **Note**

> The SCSI bus length can be extended up to 25 meters if only the controller and one drive are on the bus in a point-to-point configuration.

Single-ended Mode

If any device on the channel does *not* have LVD electrical characteristics, the channel will revert to single-ended operation mode. The SCSI bus lengths will then be limited to the single-ended bus lengths shown in Table 2-3.

Table 2-3. SCSI Formats and Bus Lengths

SCSI Trade Association (STA) Terms	Bus Speed, MB/Sec, Max.	Bus Width, Bits	Max. Bus Length, Meters		Max. Device Support (Including Controller)
			Single-ended	Low-Voltage Differential	
SCSI-1	5	8	6	-	8
Fast SCSI	10	8	3	-	8
Fast Wide SCSI	20	16	3	-	16
Ultra SCSI	20	8	1.5	-	8
Ultra SCSI	20	8	3	-	4
Wide Ultra SCSI	40	16	-	-	16*
Wide Ultra SCSI	40	16	1.5	-	8
Wide Ultra SCSI	40	16	3	-	4
Ultra2 SCSI	40	8	Not Defined	12†	8
Wide Ultra2 SCSI	80	16	Not Defined	12†	16
Ultra 160 SCSI	160	16	Not Defined	12	16

* The Maximum number of devices allowed on a Wide Ultra SCSI bus is 8, unless bus extender technology is used.

† This length can be extended to 25 meters if there are only 2 devices (e.g., the controller and one drive) on the bus in a point-to-point configuration.

Limitations on Mixing SCSI Drives

Narrow with Wide SCSI Drives

If you mix narrow and wide SCSI devices on the controller, use a terminator that does not terminate the upper eight bits, and be sure to properly terminate the end of the bus with either a 16-bit terminator or a 16-bit device that has termination enabled.

LVD with Single-ended Drives

If LVD capable drives are installed on a channel with single-ended devices, all drives on the channel will operate as if they were single-ended devices. This will also limit the bus length to the single-ended bus length specified in Table 2-3.

Controller Start-up

This chapter describes:

- **BIOS Options**
- **BIOS Configuration Utility (RAID EzAssist)**
- **Operating System, Device Drivers, GAM**
- **What to Check in Case of Problems**

This chapter describes the AcceleRAID 170 RAID controller start-up procedures and messages produced by the BIOS during start-up or re-boot. This chapter also explains three BIOS options that are available for configuring controller operation.

BIOS Options

After physically installing the controller and connecting the cabling, do the following steps if you need to set or modify a BIOS option, see "Setting BIOS Options" on page 3-2 for details:

1. Power on the computer.

2. Watch the messages on the screen for the following prompt to be displayed:

```
                Press <ALT-M> for BIOS options
```

3. Press **Alt–M** to get into the *BIOS Options* menu.

4. The *BIOS Options* menu provides the following items to choose from:

```
┌────────────────────────────────┐
│ BIOS options                   │
├────────────────────────────────┤
│ BIOS enabled                   │
│ CD-ROM boot disabled           │
│ 2 GB drive geometry            │
└────────────────────────────────┘
```

5. To select any of the items in the menu, highlight the selection with the **Up Arrow** or **Down Arrow**. Press **Enter** to toggle any of the three items.

> ☛ **Note**
>
> BIOS must be enabled to toggle the CD-ROM boot option.

Setting BIOS Options

The available BIOS options are:

- BIOS disabled / enabled
- CD-ROM boot disabled / enabled
- 2GB / 8GB drive geometry

BIOS Disable or Enable

This option must be enabled in order to toggle the CD-ROM boot parameter shown in the BIOS Options menu. The BIOS must also be enabled in order to boot from any device (e.g., CD-ROM) or system drive configured on the controller, or to access any DOS partition on any drive configured on the controller.

When BIOS Disable or Enable is selected, the following message will be displayed. Press the **Esc** key to restart the system and then watch the screen for the following messages.

```
BIOS options

BIOS enabled
CD-ROM boot disabled
2 GB drive geometry
```

```
The system will restart
Press any key to continue
```
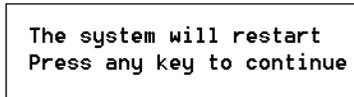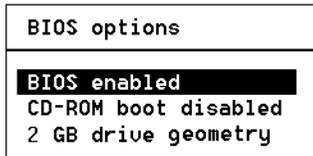
CD-ROM Boot Disable or Enable

The default for this option is for the CD-ROM boot to be disabled (e.g., the system will boot from a hard drive, even if there is a bootable CD-ROM installed–attached to the AcceleRAID 170). If the CD-ROM boot option is enabled, and if a bootable CD is installed in the CD-ROM drive, the system can boot from the CD, you will also get an option to bypass the CD-ROM boot feature.

If the CD-ROM boot option is enabled, the CD-ROM attached to the AcceleRAID 170 will take priority over the disk drives. For example, under MS-DOS, the disk drive that is normally *Drive C* will become *Drive D*. All subsequent drive IDs will similarly be moved down.

Enable 8 GByte or 2 GByte Drives

This setting affects how the BIOS reads the disk drives for the boot partition. Drive geometries can be toggled between 8 GB and 2 GB. The default is 2 GB. When the drive geometry is changed, the drive should be formatted at the operating system level.
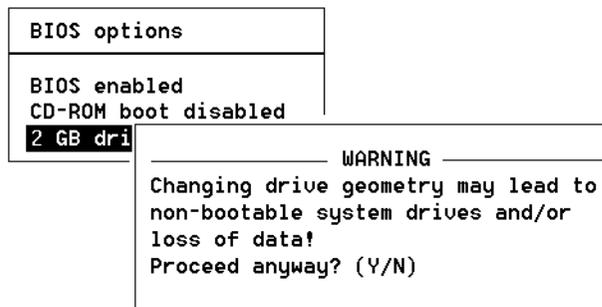
> ⚠ *Caution*
>
> Changing this setting after data has been stored will make the data unreadable. If you have already configured your array and have stored data, you should *not* change this setting.

```
BIOS options

BIOS enabled
CD-ROM boot disabled
2 GB dri                    ──── WARNING ────
            Changing drive geometry may lead to
            non-bootable system drives and/or
            loss of data!
            Proceed anyway? (Y/N)
```

The default BIOS geometry of the controller is set to 2 GB. This means that the BIOS can only access the first 2 GB of any drive that has been configured on the controller. This is adequate in most applications, since BIOS is only used to boot the operating system. However, it does mean the operating system must be installed in the first 2 GB of the capacity of the configured drive. If this is not adequate, the BIOS geometry can be changed to 8 GB, allowing the BIOS to access the first 8 GB of capacity.

As a rule of thumb, select 8 GB geometry if the following two cases apply:

- You have a system (RAID) drive that is greater than 2.145 GB in capacity.
- The DOS/Windows compatible partitions could be located in an area above the first 2.145 GB.

Otherwise the 2 GB option is fine.

☞ **Note**

> In the event that the RAID controller needs to be replaced, the current drive geometry will be restored from the configuration on disk (COD).

BIOS Configuration Utility (RAID EzAssist)

RAID EzAssist is the on-board BIOS Configuration Utility used to build several types of RAID configurations.

Refer to the *RAID EzAssist Configuration Utility User Reference Guide* or *RAID EzAssist Configuration Utility Quick Configuration Guide*.

Operating System

If an operating system is not already installed on the system, it can be installed on a system disk on the controller. The operating system is installed along with the operating system device drivers.

Operating System Device Drivers

Device drivers that are compatible with the controller can be found in the Software Kit. For details on how to install and load drivers, refer to the *PCI Disk Array Controller Drivers Installation Guide and User Manual.*

Global Array Manager (GAM) Server

The Global Array Manager Server software supports a variety of operating systems. For details on how to install GAM Server, refer to the *Global Array Manager Server Software Installation Guide and User Manual*.

Global Array Manager (GAM) Client

The controller can be configured using GAM. GAM can also be used from the server or a system client to monitor status and verify data integrity of disks connected to the controller while the system and disks are running.

For details on how to install and run GAM client, refer to the *Global Array Manager Client Software Installation Guide and User Manual*.

In Case of Problems

If problems are encountered during start-up, check the following:

- Check SCSI cabling for loose connections, pin mismatches (make sure pin 1 on the cable matches pin 1 on the connector), bent pins, and damaged or crossed cables.

- Check cable length; this includes internal bus lengths in enclosures.

- Check termination.

- Check SCSI IDs on all drives.

AcceleRAID 170 Specifications

General Hardware Specifications

AcceleRAID 170

Controller	AcceleRAID 170
CPU	i960RM microprocessor, 100MHz
Cache Memory	32MB, 64MB, and 128MB installed on a DIMM module
	Write: Selectable, Write-Through or Write-Back
	Error Protection: ECC (Error Correction Code)
Firmware	ROM Type, Flash EEPROM, 1MB x 8
PCI	32 bit, 33MHz - Host 32 bit, 33MHz - Internal PCI
SCSI	Supports a single channel Ultra 160 SCSI LVD 10160A

Environmental Specifications

Controller	**AcceleRAID 170**	
Temperature	Operating	0°C to +50°C (+32°F to +122°F)
	Storage	-20°C to +70°C (-4°F to +158°F)
Humidity	Operating	10% to 90% relative humidity (non-condensing)
	Storage	10% to 90% relative humidity (non-condensing)
Altitude	Operating	Up to 3,048m (10,000 ft)
	Storage	Up to 15,240m (50,000 ft)
Form Factor	Length:	7.575 inches
	Width:	4.200 inches
	Maximum. Component Height:	0.105 inches on the solder side of the controller 0.570 inches on the component side of the controller
Typical Power Consumption	at 5.25v at 4.75v	below 3.0A (15W) with 128MBytes SDRAM below 3.25A (11.25W) with 128MBytes SDRAM
MTBF		above 250,000 hours at 55°C

AcceleRAID 170
Error Messages

☛ **Note**

The firmware you are using may have these messages turned off. However, they are listed here for your reference.

Start-up Error Messages

The BIOS looks for any initialization message posted by the firmware during the start-up sequence. If a message is found, one of the following errors displays on screen and the installation process aborts.

```
AcceleRAID 170 fatal error--Memory test failed!

AcceleRAID 170 fatal error--Command interface test failed!

AcceleRAID 170 hardware error--Run Diagnostics to pinpoint
error

AcceleRAID 170 firmware checksum error--Reload firmware
```

Drive Check Error Messages

If the firmware finds a valid controller configuration, but it doesn't match the SCSI drives currently installed, one or more of the following messages display. Then, the BIOS prints out the following:

```
AcceleRAID 170 Configuration Checksum error--Run
configuration utility!
```

If the firmware detects that during the last power cycle the system was turned off abruptly leaving some incomplete write operations, the following message appears:

```
Recovery from mirror race in progress

WARNING: Dead SCSI devices (Channel Target) : x:y
```

The following messages may also appear:

```
AcceleRAID 170 cannot recover from Mirror Race!
Some system drives are inconsistent!
```

During the initialization, if the firmware fails to respond to the BIOS inquiry within two minutes, the following message displays:

```
AcceleRAID 170 not responding--no drives installed!
```

The BIOS then inquires the firmware for its version number and other information, and displays the following message:

```
AcceleRAID 170 Firmware Version x.xx
```

One or more of the following messages will be displayed if the firmware reports the following conditions:

```
Warning: X system drives offline

Warning: X system drives critical

WARNING: Dead SCSI devices (Channel : Target) : x:y

No system drives installed

X system drives installed
```

The BIOS repeats the same process for additional RAID controllers present in the system. Then it proceeds to boot, if possible, from the first system drive on the first controller.

Installation Abort

With Firmware 6.x, the installation aborted message is displayed when the BIOS finds that the configuration of the disk drives, as stored in the NVRAM and configuration on disk, is different from what it senses at boot time. When this happens, and a new installation is not being attempted, the cause is often a faulty cable or drive, or a loose connection. Check all of the connectors, cables, drives, and try to boot. If the error persists, it most likely indicates a genuine failure and needs to be corrected. To correct it, boot and run the on-board BIOS Configuration Utility, RAID EzAssist (see Chapter 3). For more information, refer to the *RAID EzAssist Configuration Utility User Reference Guide* or *RAID EzAssist Configuration Utility Quick Configuration Guide*.

With Firmware 6.x, if the BIOS displays a mismatch in the Configuration on Disk (COD) on all drives, then the following message will be displayed, "install abort"-- no drives will be installed message. If you get this message, boot and run RAID EzAssist, the on-board Mylex Disk Array Configuration Utility. See Chapter 3 to recover from the error. For more information, refer

to the *RAID EzAssist Configuration Utility User Reference Guide* or *RAID EzAssist Configuration Utility Quick Configuration Guide*.

System Reboot or Power Down

Status messages may also be available from LED indicators connected to the controller. The Cache Dirty indicator is especially important when preparing to power-down the system.

⚠ *Caution*

It is *very important* to make sure that all data is written to the disk before rebooting or powering down the system, or you may lose data. It is always a good idea to wait for 60 seconds or until all activity stops before resetting or rebooting the system.

The AcceleRAID 170 controller is a caching controller with 32MB, 64MB, or 128MB of cache memory when the system reports that a write command was completed, data may still be in the cache waiting to be written to the disk drives.

PCI Hot Plug

Introduction

PCI Hot Plug is a feature that allows a PCI card to be replaced while the host system is still running. The term "Hot Plug" is somewhat misleading; the PCI card cannot simply be pulled out of the host system while the card is operating without risk to the card, the system, and the data on the system.

In order to replace a Hot Plug PCI card, a software command must be invoked to power off the card slot before the card can be removed. After the software indicates that the card is unloaded and the slot is powered off, a physical card retainer/switch must be released to allow the card to be removed from the PCI bus. At this point, the card can be replaced.

At this time, Mylex only supports Hot Replacement of PCI Hot Plug cards. Future releases are planned to support Hot Upgrade or Hot Expansion (adding a card).

Implementation

Aside from the general terms previously mentioned, PCI Hot Plug implementation is specific to the host hardware platform and the operating system running on it. Refer to your host system's documentation for specific details on how to implement PCI Hot Plug.

NetWare

When NetWare is installed on a system capable of PCI Hot Plug, the following four modules are installed:

- cpqsbd.nlm - This is the Compaq system bus driver (a different driver will be needed for a platform other than Compaq).

- ncm.nlm - This is the Novell Configuration Manager, which manages the PCI Hot Plug system.

- ncmcon.nlm - This is the Hot Plug user interface called the Novell Configuration Manager Console.

- odineb.nlm - This is a module combining the Open Data-link interface and the Novell Event Bus (NEB). The NEB controls the device drivers through the Open Data-link.

If the NetWare installation process determines that the server supports PCI Hot Plug and detects the appropriate driver, the installation process adds the following two LOAD commands to the autoexec.ncf file:

- LOAD sys:\system*driver_name*

  This command loads the bus driver (for Compaq, this is ***cpqsbd.nlm***). After this command is executed, NetWare autoloads ncm.nlm.

- #LOAD sys:\system\ncmcon.nlm

  This command loads the Novell Configuration Manager Console, which then loads odineb.nlm. These commands can also be executed at the server console prompt.

  ☛ **Note**

  This command is commented out. If you want the Configuration Manager Console to be loaded every time the system is started, remove the pound sign (#) at the beginning of the line.

Perform the following steps:

1. Install NetWare 5 Service Patch 1.

2. Install the Mylex GAM DMI driver.

3. Restart the server. The autoexec.ncf will execute and load the drivers and start *ncmcon.nlm* (the PCI Hot Plug user interface).

   ☛ **Note**

   If any LOAD line is commented out in *autoexec.ncf*, the corresponding driver can be loaded manually by executing the LOAD command (as listed in *autoexec.ncf*) at the server console prompt.

Windows NT

Windows NT requires additional software from the vendor who makes the system. Since this software is not a part of NT, the software needs to be installed after the operating system is loaded. Refer to your system or server vendor's PCI Hot Plug documentation.

⚠ *Caution*

> GAM drivers can stop PCI Hot Plug Boards from unloading. If this problem occurs, stop GAM and unload the GAM drivers before attempting to unload the PCI Hot Plug controller.

Known Windows NT Issues

- Mylex Software Kit 2.1 or greater is required to support your system vendor's PCI Hot Plug utility.

- The *macdisk.sys* driver should not be loaded with a Mylex PCI Hot Plug board; if *macdisk.sys* is loaded, the system will hang upon shutdown.

- When you install a Mylex controller as a boot device and a Mylex Driver has been installed prior to the installation of the Windows NT OS, NT will not recognize the Mylex controller as a PCI Hot Plug device. To fix this, the driver must be reinstalled, and the system rebooted.

  This problem occurs because PCI Hot Plug information does not get loaded into the Windows NT registry for the Mylex controller upon installation of Windows NT.

Windows 2000

Windows 2000 supports the PCI Hot Plug capability. No additional software is required.

Please refer to the Windows 2000 documentation for instructions on how to use the PCI Hot Plug feature.

Windows 64

The released version of Windows 64 is intended to support the PCI Hot Plug capability. No additional software is required.

Please refer to the Windows 64 documentation for instructions on how to use the PCI Hot Plug feature.

Enclosure Management

Introduction

Mylex's AcceleRAID controllers support the industry standard enclosure management protocol *SCSI Accessed Fault-Tolerant Enclosures* (SAF-TE). This feature allows the host to monitor drive enclosures and detect certain faults or operating environment conditions. The host can make a decision to shut down the system or issue a warning based on the type of fault detected.

SAF-TE

The SAF-TE protocol follows a specification jointly worked out by Conner Corporation and Intel Corporation. Enclosures that are compliant with this protocol are known as SCSI Accessed Fault-Tolerant Enclosures (SAF-TE). The protocol is compatible with standard SCSI buses and cabling.

The SAF-TE interface standard's objective is to provide a non-proprietary means of allowing third-party disks and controllers to be automatically integrated with peripheral enclosures that support:

- Status Signals (LEDs, audible alarms, LCDs, etc.)

- Hot swapping of drives

- Monitoring of fans, power supplies, and enclosure temperature

SCSI is the underlying transport mechanism for communicating enclosure information. All standard SCSI host adapters will work. There is no need to consider reserved signals or special cabling.

The SAF-TE interface can be implemented as a SCSI target that uses a SCSI port and an 8-bit microcontroller.

All communication is initiated by the host. The SAF-TE processor acts only in target mode. The SAF-TE processor is periodically polled by the host approximately every 2 to 10 seconds.

SES

The AcceleRAID 170 supports SES (SCSI Enclosure System) cabinets.
Please refer to the documentation supplied with your SES enclosure cabinet
for details on how to take advantage of this feature.

Regulatory Information

FC Class B Compliance

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION
IS SUBJECT TO THE FOLLOWING TWO CONDITIONS:

1. THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE,
   AND

2. THIS DEVICE MUST ACCEPT ANY INTERFERENCE
   RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE
   UNDESIRED OPERATION.

All external connections should be made using shielded cables.

This equipment has been tested and found to comply with the limits for a Class B
digital device, pursuant to Part 15 of the FCC rules. These limits are designed to
provide reasonable protection against harmful interference in residential installations.
This equipment generates, uses, and can radiate radio frequency energy, and if not
installed and used in accordance with the instructions, may cause harmful interference
to radio communications. However, there is not guarantee that interference will not
occur in a particular installation.

If this equipment does cause interference to radio or television equipment reception,
which can be determined by turning the equipment off and on, the user is encouraged
to try to correct the interference by one or more of the following measures:

1. Reorient or relocate the receiving antenna

2. Move the equipment away from the receiver

3. Plug the equipment into an outlet on a circuit different from that to which the
   receiver is powered.

If necessary, the user should consult the dealer or an experienced radio/television
technician for additional suggestions.

⚠ *Caution*

Only equipment certified to comply with Class B
(computer input/output devices, terminals, printers,
etc.) should be attached to this equipment.

Any changes or modifications to the equipment by the
user not expressly approved by the grantee or
manufacturer could void the user's authority to
operate such equipment.

FC Declaration of Conformity

Per FCC Part 2, Section 2.1077(a)

Manufacturer's Name: Mylex Corporation
Manufacturer's Address: 34551 Ardenwood Blvd.
Fremont, CA 94555-3607
USA

Declares that the product:

Product Name: AcceleRAID 170 Ultra 160 SCSI RAID
Controller

Model Number(s):   A170-1-32NB

A170-1-64NB

A170-1-128NB

Year of Manufacture: 2000

Conforms to the following Product Specification(s):

FCC: CFR 47 Part 15, Subpart B, Section 15.107(e)
and Section 15.109(g) Class B Digital Device
tested per ANSI C63.4–1992 procedures

Supplementary Information:

This device complies with part 15 of the FCC Rules. Operation is subject to
the following two conditions: (1) This device may not cause harmful
interference, and (2) this device must accept any interference received,
including interference that may cause undesired operation.

ϵ Declaration of Conformity

Per 89\336\EEC

Responsible Party

Name: Mylex Corporation

Address: 34551 Ardenwood Boulevard

                   Fremont, CA 94555-3607

                   U.S.A.

hereby declares that the product

Trade Name: AcceleRAID 170 Ultra 160 SCSI RAID Controller

                   Fab 550166-00 Rev A

Model Number(s): A170-1-32NB

                   A170-1-64NB

                   A170-1-128NB

conforms to the following specifications

Standards: EN 50081-1:1992, Emissions

                   EN 55022:1998 Class B ITE radiated and conducted
                   emissions

                   EN 50024:1998, Immunity

                   EN 61000-4-2:1998 Electrostatic Discharge

                   EN 61000-4-3:1998 Radiated Immunity

                   EN 61000-4-4:1995 Electrical Fast Transients/Burst

                   EN 61000-4-5:1995 Surges

                   EN 61000-4-6:1996 Conducted Immunity

                   EN 61000-4-11:1994 Supply Dips and Variations

ϵ Community of Europe

CE mark is rated for the AcceleRAID™ 170
PCI to Ultra 160 SCSI RAID Controller
as follows:

CISPR 22 Radiated Emission

EN55022, Generic immunity standard for the following:
IEC 801-2 ESD, IEC 801-3 Radiated, and IEC 801-4 EFT/Burst

Warning!

This is a Class B product. In a residential environment this product may cause radio interference, in which case the user may be required to take adequate measures.

Achtung!

Dieses ist ein Gerät der Funkstörgrenzwertklasse B. In Wohnbereichen können bei Betrieb dieses Gerätes Rundfunkstörungen aufreten, in welchen Fällen der Benutzer für entsprechende Gegenmaßnahmen verantwortlich ist.

Avertissement!

Cet appareil est un appareil de Classe B. Dans un environnement résidentiel cet appareil peut provoquer des brouillages radioélectriques. Dans ce cas, il peut être demandé à l'utilisateur de prendre des mésures appropriées.

Underwriters Laboratories Statement and Warning

Glossary
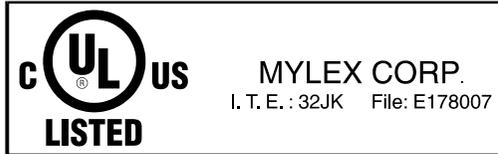
AcceleRAID™

The AcceleRAID family features high performance, cost effective Ultra SCSI/Ultra2 SCSI LVD and Ultra 160 SCSI to PCI RAID controllers and adapters for high-end desktops, workstations, and entry level and mid range servers. AcceleRAID controllers support PCI-based motherboards with embedded SCSI chips and systems that have a PCI expansion slot designated for add-in RAID controllers. The AcceleRAID family consists of the 150, 200, 250, 352, 160, 170, and 170LP controllers. The 150, 200, and 250 products can utilize the on-board SCSI chips of servers and use SCSI interrupt steering logic (*SISL*). In addition, the 150 and 250 products can work in any PC or server with a PCI slot whether or not they have SCSI interrupt steering logic. The 150 and 250 have one Ultra2 SCSI LVD channel.

Active Termination

A type of terminator used in current SCSI channel setups, which utilizes an active voltage regulator, thus closely matching cable impedance.

Application Server

A centralized computer that holds and distributes application programs to users.

ASIC

Application-Specific Integrated Circuit, a chip created for a specific application.

Array

Multiple disk drives configured to behave as a single, independent disk drive. See also *Disk Array.*

Asynchronous Data Transfer

Data transfer not synchronized to a set timing interval. Asynchronous devices must wait for a signal from the receiving device after each byte of data.

Automatic Rebuild

Mylex controllers provide automatic rebuild capabilities in the event of a physical disk drive failure. The controller performs a rebuild operation automatically when a disk drive fails and both of the following conditions are true:

A standby or hot spare disk drive of identical or larger size is found attached to the same controller;

All system drives that are dependent on the failed disk drive are configured as a redundant array: RAID 1, RAID 3, RAID 5, or RAID 0+1.

During the automatic rebuild process, system activity continues; however, system performance may degrade slightly.

BBU

Battery Backup Unit, provides a battery backup for data currently stored in the on-board cache memory during intermittent power loss to the controller. In the event of a power failure, the BBU can hold data in the cache for a certain amount of time. Once power is restored the data can be saved to a disk.

BIOS

Basic Input/Output System, software that determines what a computer can do without accessing programs. The BIOS contains all the code required to control the keyboard, screen, drives, serial communications, and other functions. Usually the BIOS is built into a ROM chip installed on the motherboard so that the BIOS will always be available and not affected by disk failure. Sometimes the BIOS is recorded on a flash memory chip.

BIOS Configuration Utility

BIOS-based Configuration Utility, a utility program sequence used, upon powerup, for configuring various hardware elements in a system.

Booting (or Bootstrapping)

Loading operating system code and other basic software from a disk or other storage device to help a computer start.

Burst Data Rate

The speed at which a specific amount of data is sent or received in intermittent operations.

Bus

A set of conductors that connect the functional units in a computer and are the channels through which data is transferred. There are several types of bus channels, including serial, parallel, PCI, ISA, EISA, and MCA. See also *I/O Bus*.

Cables

The physical wires (copper or fibre optic) over which electrical signals are transmitted. Cables are used to connect peripherals (such as disk arrays) to computers and servers or to connect peripherals or components to each other.

Cache

A temporary storage area for frequently accessed or recently accessed data. Cache is used to speed up data transfer to and from a disk. See also *Caching*.

Cache Flush

Refers to an operation where all unwritten blocks in a *Write-Back Cache* are written to the target disk. This operation is necessary before powering down the system.

Cache Line Size

Represents the size of the data "chunk" that will be read or written at one time, and is set in conjunction with stripe size. Under RAID EzAssist^{TM}, the cache line size (also known as *Segment Size*) should be based on the stripe size you selected. The default segment size for Mylex RAID controllers is 8K.

Caching

Allows data to be stored in a pre-designated area of a disk or RAM. Caching speeds up the operation of RAID systems, disk drives, computers and servers, or other peripheral devices.

CD-ROM

Compact Disk-Read Only Memory, a removable read-only storage device, similar to an audio compact laser disk, holding up to 640MB of data.

Channel

Any path used for the transfer of data and control of information between storage devices and a storage controller or I/O adapter. Also refers to one SCSI bus on a disk array controller. Each disk array controller provides at least one channel.

Conservative Cache

An operating mode in which system drives configured with the write-back caching policy are treated as though they were configured for write-through operation and the cache is flushed.

Consistency Check

A process that verifies the integrity of redundant data. A consistency check on a RAID 1 or RAID 0+1 configuration (mirroring) checks if the data on drives and their mirrored pair are exactly the same. For RAID Level 3 or RAID Level 5, a consistency check calculates the parity from the data written on the disk and compares it to the written parity. A consistency check from Mylex utilities such as Global Array Manager^{TM} (GAM) or RAID EzAssist^{TM} give the user the ability to have a discrepancy reported and corrected. See also *Parity Check*.

Data Transfer Rate

The amount of data per unit of time moved through a channel or I/O Bus in the course of execution of an I/O load, usually expressed in MBps.

DB-9

A type of connector used for serial interfaces.

Device Driver

A software program that controls a particular type of device attached to a computer, such as a RAID subsystem, printer, display, CD-ROM, disk drive, etc.

DIMM

Dual In-line Memory Module, a circuit board that has memory chips. Instead of installing two SIMMs for the 64-bit memory path on a Pentium processor, one DIMM can be installed. See also *SIMM*.

Disk

A non-volatile, randomly addressable, re-writable data storage device, including rotating magnetic and optical disks as well as solid-state disks or other electronic storage elements.

Disk Array

A collection of disks from one or more commonly accessible disk systems. Disk arrays, also known as RAID, allow disk drives to be used together to improve fault tolerance, performance, or both. Disk arrays are commonly used on servers and are becoming more popular on desktops and workstations. See also *Array*.

Disk Drive

A device for the electronic digital storage of information.

Disk System

A storage system capable of supporting only disks.

Drive Groups, Drive Packs

A group of individual disk drives (preferably identical) that are logically tied to each other and are addressed as a single unit. In some cases this may be called a drive "pack" when referring to just the physical devices.

All the physical devices in a drive group should have the same size; otherwise, each of the disks in the group will effectively have the capacity of the smallest member. The total size of the drive group will be the size of the smallest disk in the group multiplied by the number of disks in the group. For example, if you have 4 disks of 400MB each and 1 disk of 200MB in a pack, the effective capacity available for use is only 1000MB (5x200), not 1800MB.

Drivers

A software routine that receives I/O requests from higher levels within the operating system and converts those requests to the protocol required by a specific hardware device.

Dual Active

A pair of components, such as storage controllers in a failure tolerant storage system, that share a task or set of tasks when both are functioning normally. When one component of the pair fails, the other takes the entire load. Dual

active controllers (also called *Active/Active* controllers) are connected to the same set of devices and provide a combination of higher I/O performance and greater failure tolerance than a single controller.

ECC

Error Correcting Code, a method of generating redundant information which can be used to detect and correct errors in stored or transmitted data.

EDO

Extended Data Output, a type of random access memory (*RAM*) chip designed to improve the time to read from memory on faster microprocessors such as the Intel® Pentium.

EEPROM

Electrically Erasable PROM, see *EPROM*.

EISA

Extended Industry Standard Architecture, a bus standard for PCs extending the *ISA* architecture to 32 bits and allowing more than one CPU to share the bus.

Embedded Storage Controller

An intelligent storage controller that mounts in a host computer's housing and attaches directly to a host's memory bus with no intervening I/O adapter or I/O bus.

EPROM

Erasable Programmable Read Only Memory, memory which can be erased and re-used.

eXtremeRAID

A family of Mylex RAID controllers which offer uncompromising fault tolerance, data availability, superior configuration, and management flexibility. The eXtremeRAID family incorporates the latest performance technology by using the fastest processor on a PCI based RAID solution, a 233 MHz RISC processor, up to four 160MB/sec Ultra 160 SCSI (Ultra3 SCSI) channels, and a 64-bit PCI interface to provide eXtreme performance for servers. The eXtremeRAID controllers use driver technology with which Mylex has won tpm-C benchmarks worldwide. With this technology, the

eXtremeRAID 1100, 2000, and 3000 provide the highest performance and most flexible RAID solution available today.

Failback

Restoring a failed system component's share of a load to a replacement component.

Failover

A mode of operation for failure tolerant systems in which a component has failed and a redundant component has assumed its functions.

Failover Port

A fibre channel port capable of assuming I/O requests for another, failed port on the loop. During normal operation, a failover port may be active or inactive. Failover ports assume the same loop ID and, optionally, the same node from the failed port.

Failure

A detectable physical change in hardware, requiring replacement of the component.

Fast SCSI

Devices that increases the speed at which data is transferred as opposed to the volume of data. These devices use data rates up to 10 MHz.

Fast/Wide SCSI

SCSI devices using data rates up to 20 MHz.

Flash ROM

Memory on an adapter containing software that can be reprogrammed without removing it from the board.

Format

A pre-established layout for data. Programs accept data as input in a certain format, process it, and provide it as output in the same or another format. All data is stored in some format with the expectation that it will be processed by a program that knows how to handle that format.

Gigabit

10^9 (1,000,000,000) bits. Abbreviated as Gb.

Gigabyte

2^{30} (1,073,741,824) bytes. Abbreviated as G or GB.

Global Array Manager (GAM)

A Mylex RAID management utility that allows a system administrator to configure, monitor, and manage network RAID storage from anywhere in the world. GAM can communicate critical notification via e-mail, fax, pager, SNMP or the launching of an application. GAM is everything needed to manage Mylex PCI RAID Controllers, SCSI Host Adapters, and External RAID Controllers.

HDM

Hardware Driver Module, a driver set required for SCSI adapters for use in an I_2O environment.

Host

Any computer system to which disks are attached and accessible for data storage and I/O.

Host Bus Adapter (HBA)

An I/O adapter that connects a host I/O bus to the host's storage memory system.

Host I/O Bus

An I/O bus used to connect a host computer to storage systems or storage devices.

Hot Plug

The process of adding or removing a device from a bus while transactions involving other devices are occurring over the bus. See also *PCI Hot Plug*.

Hot Replacement of Disks

The design of all Mylex controllers allows for the replacement of failed hard disk drives without interruption of system service. In the event of a SCSI drive failure on a properly configured system (where the data redundancy features of the controller are used), the system generates a message to alert the system operator.

When a replacement drive becomes available, the system operator can remove the failed disk drive, install a new disk drive, and instruct the

controller to "rebuild" the data on the new drive, all without interrupting system operations. Once the rebuild is complete, the controller will be brought back into a fault tolerant state. See also *Hot Swap*.

Hot Spare

A physical disk drive not part of a system drive that the controller can use to automatically rebuild a critical system drive. The hot spare drive must have at least as much capacity as the largest disk drive in the array or the rebuild may not start. See also *Hot Standby*.

Hot Standby

A redundant component in a fault tolerant storage system that has power applied and is ready to operate, but which does not perform its task as long as the primary component for which it is standing by is functioning properly. See also *Hot Replacement of Disk* and *Hot Spare*.

Hot Swap

The exchange of a replacement unit in a storage system for a defective unit. The exchange requires human intervention, but the system can continue to perform its normal functions (compare with *Auto Swap*, *Cold Swap*, and *Warm Swap*). See also *Hot Replacement of Disk*.

In-Line Terminator

A plug attached to the end of a SCSI cable in order to initiate active termination. Used when SCSI devices on the cable do not have built-in termination. See also *Active Termination*.

Interface

A hardware or software protocol that manages the exchange of data between the hard disk drive and the computer. The most common interfaces for small computer systems are ATA (also known as IDE) and SCSI.

Internal RAID Controller

A controller circuit board that resides inside a computer or server. An internal RAID controller resides on a bus, such as the PCI bus. Examples of internal RAID controllers include the Mylex AcceleRAID and eXtremeRAID families.

I/O

Input/Output, the transmission of information between an external source and the computer.

I/O Bus

Any path used for the transfer of data and control information between I/O adapters and storage controllers or storage devices. See also *Bus*.

I$_2$O

Intelligent Input/Output, a driver that uses special I/O processes to eliminate I/O bottlenecks. The processes deal with interrupt handling, buffering, and data transfer. An I$_2$O driver also includes an OS-specific module (OSM), which handles higher-level OS details, and a hardware device module (*HDM*), which knows how to communicate with certain devices.

ISA

Industry Standard Architecture, a standard bus (computer interconnection) architecture associated with the IBM AT motherboard. It allows 16 bits at a time to flow between the motherboard circuitry and an expansion slot card and its associated device(s).

JBOD

Just A Bunch of Disks (Drives), a number of disk drives, usually in an enclosure. JBOD implies that the disks do not use RAID technology and function independently. All Mylex RAID controllers support JBOD mode.

Jumper

A short piece of electrical conductor encased in plastic used to connect pins on a device to provide settings that the user can change. The settings remain constant during operation. For example, jumpers often set SCSI ID, termination, and IDE master/slave settings.

Kilobyte

2^{10} (1,024). Abbreviated as K or KB.

Logical Drive

The logical devices presented to the operating system. System drives are presented as available disk drives, each with a capacity specified by the Mylex RAID controller.

Logical Drive States

A logical (system) drive can be *Online*, *Critical*, or *Offline*. Notice that the term "online" is used for both physical and logical drives.

LVD

Low Voltage Differential, a form of SCSI signaling introduced with *Ultra2 SCSI (Fast40 SCSI)* uses data high and data low signal lines to increase transmission distances over those of single-ended (conventional SCSI signaling) lines. LVD allows for cable lengths of up to 12 meters (approximately 39 feet) with up to 15 devices. LVD also lowers noise, power usage, and amplitude.

LVD differs from conventional differential signaling in that only positive and negative values are distinguished, not voltage levels. Other advantages are that LVD devices consume less power and can sense single-ended devices on the bus and revert to single-ended signaling. Devices need to be Ultra2 SCSI LVD devices in order to take advantage of the LVD signaling. Mylex AcceleRAID, eXtremeRAID, and DAC FL controllers are LVD controllers.

Megabit

A million bits; used as a common unit of measure, relative to time in seconds, as an expression of a transmission technology's bandwidth or data transfer rates. Megabits per second (Mbps) is a frequent measure of bandwidth on a transmission medium.

Megabyte

2^{20} (1,048,576) bytes. One megabyte can store more that one million characters. Abbreviated as M or MB.

Mirrored Cache

A cache memory that has duplicate data from another controller. In the event of failure of the original controller, the second controller can take the cached data and place it on the disk array.

Mirrored Hard Drive

Two hard drives the computer sees as one unit. Information is stored simultaneously on each drive. If one hard disk drive fails, the other contains all of the cached data and the system can continue operating.

Mirroring

Refers to the complete duplication of data on one disk drive to another disk drive, this duplication occurs simultaneously with each write operation: each disk will be the mirror image of the other (also known as RAID Level 1, see *RAID levels*). All Mylex RAID controllers support mirroring.

M.O.R.E.

Mylex Online RAID Expansion, an advanced configuration mode that allows expansion of any unconfigured or hot spare drive into the expandable drive group while the controller is online with the host. For example, a system using a five-disk-drive RAID set can add another disk drive to create a six-disk-drive RAID set. The M.O.R.E. operation can be performed on all RAID levels except JBOD.

Mylex's Global Array Manager (GAM) supports two M.O.R.E. features:

Expand Capacity allows logical drive expansion for FFx external controllers only.

Expand Array allows array expansion for both PCI and FFx external controllers.

During the RAID set expansion process, which includes re-striping data from the old (smaller) RAID set to the new (expanded) RAID set, the controller continues to service host I/O requests.

MTBF

Mean Time Between Failures, the average time from start of use to failure in a large population of identical systems, computers, or devices.

Narrow SCSI

8-bit wide standard SCSI. Compare with *Fast SCSI*, *Fast/Wide SCSI*, *Ultra SCSI*, *Ultra Wide SCSI*, *Ultra Fast SCSI*, *Ultra 160 SCSI*, and *WideSCSI*.

NVRAM

Non-Volatile Random Access Memory, a memory unit equipped with a battery so that the data stays intact even after the main power had been switched off.

Offline

A *Logical Drive* is in an "offline" state if no data can be read from it or written to it. Offline does not apply to physical disk drives. System commands issued to offline logical drives are returned with an error status; no operations can be performed on offline logical drives. See also *Logical Drive States*, *Online*, and *Critical*.

Online

A *Logical Drive* is in an "online" state if all of its participating SCSI drives have power and are operational. See also *Logical Drive States*, *Critical*, and *Offline*.

Parity

A method of providing complete data redundancy while requiring only a fraction of the storage capacity of mirroring. The data and parity blocks are divided between the disk drives in such a way that if any single disk drive is removed or fails, the data on it can be reconstructed using the data on the remaining disk drives. The parity data may exist on only one disk drive or be distributed between all disk drives in a RAID group.

Parity Check

A function used to verify the integrity of data on a system drive. It verifies that mirror or parity information matches the stored data on the redundant arrays. If the parity block information is inconsistent with the data blocks, the controller corrects the inconsistencies. See also *Consistency Check*.

PCI

Peripheral Component Interconnect, a standardized architecture that provides a high-speed data path between peripherals and the CPU. PCI is a high-performance, backplane interface, expansion slot architecture found on PCs, Macintoshes, and UNIX workstations. PCI cards are portable across hardware platforms with the help of various software drivers.

PCI Hot Plug

A feature that allows for the printed circuit board (PCB) to be replaced without powering down the entire system—an essential feature in newer PCI-based PCs. Mylex DAC960PG, DAC960PJ, AcceleRAID, and eXtremeRAID products are all PCI Hot Plug compatible. See also *Hot Plug*.

Physical Device

Any device connected to some kind of hardware. For example, SCSI disk, fibre disk, network disk, RAM disk, etc.

Physical Disk Drive

A single hard disk drive. Each physical disk drive is assigned a unique identification address.

PROM

Programmable Read-Only Memory, memory that users with appropriate instructions can reprogram.

Protocol

A special set of rules for transmitting data between two devices in a telecommunication connection.

RAID

Redundant Array of Independent Disks, a collection of two or more disks working together in an array. DAC960 controllers implement this technology to connect up to 15 SCSI devices per channel. The different forms of RAID implementation are known as "RAID levels."

The system manager or integrator selects the appropriate RAID level for a system. This decision will be based on which of the following are to be emphasized:

Disk Capacity

Data Availability (redundancy or fault tolerance)

Disk Performance

RAID Adapters

See *RAID Controller.*

RAID Advisory Board (RAB)

An association of companies whose primary intention is to standardize RAID storage systems. Mylex is a member of RAB.

RAID Controller

Low cost RAID controllers that use SCSI channels on the motherboard.

RAID Levels

Mylex disk array controllers support four RAID Advisory Board approved (RAID 0, RAID 1, RAID 3, and RAID 5), two special (RAID 0+1, and JBOD), and three spanned (RAID 10, 30, and 50) RAID levels. All DAC960, AcceleRAID, and eXtremeRAID series controllers support these RAID levels.

Level 0: Provides block "striping" across multiple drives, yielding higher performance than is possible with individual drives. This level does not provide any redundancy.

Level 1: Drives are paired and mirrored. All data is 100 percent duplicated on a drive of equivalent size.

Level 3: Data is "striped" across several physical drives. Maintains parity information, which can be used for data recovery.

Level 5: Data is "striped" across several physical drives. For data redundancy, drives are encoded with rotated XOR redundancy.

Level 0+1: Combines RAID 0 striping and RAID 1 mirroring. This level provides redundancy through mirroring.

JBOD: Sometimes referred to as "Just a Bunch of Drives." Each drive is operated independently like a normal disk controller, or drives may be spanned and seen as a single drive. This level does not provide data redundancy.

Level 10: Combines RAID 0 striping and RAID 1 mirroring spanned across multiple drive groups (super drive group). This level provides redundancy through mirroring and better performance than Level 1 alone.

Level 30: Data is "striped" across multiple drive groups (super drive group). Maintains parity information, which can be used for data recovery.

Level 50: Data is "striped" across multiple drive groups (super drive group). For data redundancy, drives are encoded with rotated XOR redundancy.

Note: The host operating system drivers and software utilities remain unchanged regardless of the level of RAID installed. The controller makes the physical configuration and RAID level implementation.

RAID Migration

A feature in RAID subsystems that allows for changing a RAID level to another level without powering down the system.

RAM

Random Access Memory, the "built-in" readable and writable data storage that comes with (or can be added to) a computer.

RISC

Reduced Instruction Set Computing, architecture for an application-specific processor.

RJ-11, RJ-45

Registered Jacks (sometimes described as RJ-XX), a series of telephone connection interfaces (receptacle and plug) that are registered with the U.S. Federal Communications Commission (FCC). The most common telephone jack is the RJ-11 jack, which can have six conductors but is usually implemented with four. The RJ-11 jack is likely to be the jack that your household or office phones are plugged into from the ordinary "untwisted" wire (sometimes called "gray satin" or "flat wire") that people are most familiar with. The RJ-45 is a single-line jack for digital transmission over ordinary phone wire, either untwisted or twisted; the interface has eight pins or positions.

ROM

Read-Only Memory, built-in computer memory containing data that normally can only be read, not written to. ROM contains the programming that allows a computer to be "booted up" each time you turn it on. Unlike a computer's random access memory (*RAM*), the data in ROM is not lost when the computer power is turned off; a small long-life battery in your computer sustains the ROM.

SAF-TE

SCSI Accessed Fault-Tolerant Enclosure, an "open" specification designed to provide a comprehensive standardized method to monitor and report status information on the condition of disk drives, power supplies, and cooling systems used in high availability *LAN* servers and storage subsystems. The specification is independent of hardware I/O cabling, operating systems, server platforms, and RAID implementation because the

enclosure itself is treated as simply another device on the SCSI bus. Many other leading server, storage, and RAID controller manufacturers worldwide have endorsed the SAF-TE specification. Products compliant with the SAF-TE specification will reduce the cost of managing storage enclosures, making it easier for a LAN administrator to obtain base-level fault-tolerant alert notification and status information. All Mylex RAID controllers feature SAF-TE.

SCSI

Small Computer System Interface, a technological standard that defines connections between computers and peripheral devices.

SCSI Adapters

Storage controllers for managing SCSI devices.

SCSI Drive

A disk drive equipped with a SCSI interface (sometimes referred to as a SCSI Disk). Each disk drive will be assigned a SCSI address (or SCSI ID), which is a number from 0 to 7 (0 to 15 under wide or Ultra SCSI). The SCSI address uniquely identifies the drive on the SCSI bus or channel.

SCSI Drive States

Refers to a SCSI drive's current operational status. At any given time, a SCSI drive can be in one of five states: *Ready*, *Online*, *Standby*, *Dead*, or *Rebuild*.

The controller stores the state of the attached SCSI drives in its non-volatile memory. This information is retained even after power-off. Hence, if a SCSI disk is labeled "dead" in one session, it will stay in the "dead" state until a change is made either by using a system level utility or after a rebuild. Each state is described below:

Ready: A SCSI disk drive is in a "ready" state if it is powered on and is available to be configured during the current session but remains unconfigured.

Online: A SCSI disk drive is in an "online" state if is powered on, has been defined as a member of a drive group, and is operating properly.

Standby: A SCSI disk drive is in a "standby" state if it is powered on, is able to operate properly, and was NOT defined as part of any drive group.

Offline: A SCSI disk drive is in a "offline" state if it is not present, if it is present but not powered on, or if it failed to operate properly and was "offline" by the controller. When the controller detects a failure on a disk, it "kills" that disk by changing its state to "offline." An "offline" SCSI drive can also be present and powered on, but a SCSI drive in a "offline" state does not participate in any I/O activity; no commands are issued to dead drives.

Rebuild: A SCSI disk drive is in a "rebuild" state while it is in the process of being rebuilt. During this process, data is regenerated and written to the disk drive. This state is also referred to as "Write-Only" (WRO).

SCSI Interrupt Steering Logic (SISL)

Architecture that allows a RAID controller, such as AcceleRAID 150, 200 or 250, to implement RAID on a system board-embedded SCSI bus or a set of SCSI busses.

SDRAM

Synchronous Dynamic Random Access Memory, a form of dynamic random access memory (DRAM) that can be coordinated or synchronized to the clock speed of the computer.

Segment Size

See *Cache Line Size.*

Sequential I/O

A type of read and write operation where entire blocks of data are accessed one after another in sequence, as opposed to randomly.

Server

A computer program that provides and manages services to other computer programs on the same or other computers. The computer that a server program runs in is also frequently referred to as a server.

SES

SCSI Enclosure Services, a standard for SCSI access to services within an enclosure containing one or more SCSI devices. For disk drives, power supplies, cooling elements, and temperature sensors, the actions performed are the same as for SAF-TE monitoring. If a UPS is connected to any SES-monitored enclosures, and an AC failure or two minute warning is

reported, conservative cache is enabled and all system drives are switched to write-through cache. Primarily used in fibre enclosures.

SIMM

Single In-line Memory Module, RAM packed on a small circuit board with a defined edge connector. Two SIMMs are required for a 64-bit memory path on a Pentium processor. See also *DIMM*.

SISL

See *SCSI Interrupt Steering Logic (SISL)*.

SMART

Self-Monitoring Analysis and Reporting Technology, the industry standard reliability prediction indicator for both the ATA/IDE and SCSI hard disk drives. Hard disk drives with SMART offer early warning of some hard disk failures so critical data can be protected.

SNMP

Simple Network Management Protocol, the protocol governing network management: for monitoring network devices and their functions.

Standard Disk Drive

This term refers to a hard disk drive with SCSI, IDE, or other interface, attached to the host system through a standard disk controller.

Standby Replacement of Disks

See also *Hot Spare*. One of the most important features the RAID controller provides to achieve automatic, non-stop service with a high degree of fault-tolerance. The controller automatically carries out the rebuild operation when a SCSI disk drive fails and both of the following conditions are true:

A "standby" SCSI disk drive of identical size is found attached to the same controller;

All of the system drives that are dependent on the failed disk are redundant system drives, e.g., RAID 1, RAID 3, RAID 5, and RAID 0+1.

Note: The standby rebuild will only happen on the SAME DAC960 controller, never across DAC960 controllers.

During the automatic rebuild process, system activity continues as normal. System performance may degrade slightly during the rebuild process.

To use the standby rebuild feature, you should always maintain a standby SCSI disk in your system. When a disk fails, the standby disk will automatically replace the failed drive and the data will be rebuilt. The system administrator can disconnect and remove the bad disk and replace it with a new disk. The administrator can then make this new disk a standby.

The standby replacement table has a limit of 8 automatic replacements in any session (from power-on/reset to the next power-off/reset). When the limit of 8 is reached and a disk failure occurs, the standby replacement will occur but will not be recorded in the replacement table.

To clear the "standby replacement" table, reboot the system from a DOS bootable floppy, run the configuration utility and select the option 'view/ update configuration' from the main menu. A red box labeled 'Drive Remap List' will be displayed. Selecting the box will allow you to continue. You should save the configuration without making any changes, and exit the configuration utility. This will clear the replacement table. You may now proceed to boot your system and continue normal operations.

In normal use, the replacement table limit of 8 should not cause any problems. Assuming that a disk fails about once a year (drives we support generally come with a 5-year warranty), the system would run continuously for a minimum of eight years before the table would need to be cleared.

Stripe Order

The order in which SCSI disk drives appear within a drive group. This order must be maintained, and is critical to the controller's ability to "rebuild" failed drives.

Stripe Size

The size, in kilobytes (1024 bytes) of a single I/O operation. A stripe of data (data residing in actual physical disk sectors, which are logically ordered first to last) is divided over all disks in the drive group.

Stripe Width

The number of striped SCSI drives within a drive group.

Striping

The storing of a sequential block of incoming data across multiple SCSI drives in a group. For example, if there are 3 SCSI drives in a group, the data will be separated into blocks and block 1 of the data will be stored on SCSI

drive 1, block 2 on SCSI drive 2, block 3 on SCSI drive 3, block 4 on SCSI drive 1, block 5 on SCSI drive 2, and so on. This storage method increases the disk system throughput by ensuring a balanced load among all drives.

Sustained Data Transfer Rate

A rate of data transfer defined for continuous operation at a maximum speed level.

Synchronous Data Transfer

Data transmission synchronized to a defined time interval, and is faster than asynchronous SCSI because there is no wait for acknowledgement of each byte from the receiving device (up to 20MHz).

System Drives

A system drive is equivalent to a logical drive. System drives are presented to the operating system as available disk drives, each with a capacity specified by the eXtremeRAID controller.

Target ID

The SCSI ID of a device attached to a controller. Each SCSI channel can have up to 15 attached SCSI devices (target ID from 0 to 6 and 8 to 15).

Terminator

A part used to end a SCSI bus.

Termination

A method of matching transmission impedance of a bus to eliminate signal reflections from the physical ends of the bus.

Transfer Rate

The rate at which data moves between the host computer and storage, input, or output devices, usually expressed as a number of characters per second.

Ultra 160 SCSI (Ultra3 SCSI)

The newest in SCSI technology, Ultra 160 SCSI increases performance, reliability, and manageability. With transfer rates of 160 MBps, cyclical redundancy check, and the capability to automatically test the interface's performance level, the Ultra 160 SCSI can keep up with fibre channel technology.

Ultra SCSI (Fast 20 SCSI)

A high performance SCSI protocol that has a bus speed of 20 Megabytes per second in the Narrow SCSI configuration and 40 MB in the Wide SCSI (Fast 20 Wide SCSI) configuration.

Ultra Wide SCSI

16-bit wide Ultra SCSI (IS devices), double the speed of narrow SCSI.

Ultra2 SCSI (Fast 40 SCSI)

A higher performance SCSI protocol than Ultra SCSI. Ultra2 SCSI has a bus speed of 40 Megabytes per second in the Narrow SCSI configuration and 80 Megabytes in the Wide SCSI (Wide Ultra2 SCSI) configuration.

Wide SCSI

A SCSI protocol and signal definition providing 16-bit wide data path.

Write-Back Cache

A caching strategy whereby write operations result in a completion signal being sent to the host operating system as soon as the cache (not the disk drive) receives the data to be written. The target disk drive will receive the data at a more appropriate time in order to increase controller performance. An optional cache battery backup can be used to protect against data loss as a result of a power failure or system crash.

Write-Through Cache

A caching strategy whereby data is written to the SCSI drive before a completion status is returned to the host operating system. This caching strategy is considered more secure, since a power failure will be less likely to cause loss of data. However, a write through cache results in a slightly lower performance.

Index

MYLEX AcceleRAID 170 Problem Report

Customer Identification	AcceleRAID 170 Identification
Name: _____ Company: _____ Address: _____ _____ _____ Country: _____ Phone Number:_____ Fax Number:_____	Date: Purchase Date: Model: Invoice Number: Serial Number: # Chnls: Cache: Firmware Ver: BIOS Ver: Make/Model/Size/Type of Drives: Disk: Non-Disk:

System Information

Motherboard: _____	CPU Speed:	BIOS Ver:
Video Adapter: _____	Network Card:	MB Memory:
Operating Sys: _____	Other Disk Ctrl:	Other Cards:

Pack Configuration / System Drive Configuration

Indicate in matrix below 1, 2... for member of pack 1, pack 2... respectively. Indicate S, T, C, or O for Standby, Tape, CDROM and other drives.

Chan-nel	SCSI ID																System Drive	Size	RAID Level	Write Back/ Thru
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0			
																	1			
0																	2			
1																	3			
2																	4			
																	5			
																	6			
																	7			

Problem Description

_____
_____
_____
_____
_____
_____
_____
_____

Mylex Warranty - Customer Policy

Thank you for purchasing this Mylex product for your computer system. In addition to this high-quality product, your purchase entitles you to the warranty coverage set forth herein. In order to provide this warranty coverage, and to indicate your acceptance of this warranty, we must have the attached Warranty Registration Card completed and returned to us within 15 days of your purchase. Also, in order for us to provide you the highest level of service, we must know where you purchased your MYLEX product.

Three Year Limited Warranty

If at any time during the thirty six month period (18 months for BBM/BDIMM) immediately following the date of original purchase of the MYLEX product enclosed herewith (the "PRODUCT") you discover one or more defects in the material or workmanship, MYLEX will repair, or at MYLEX's sole option, replace the PRODUCT. If the PRODUCT fails to operate at any time within seven days after the date of its original purchase, it will be replaced by MYLEX. Such repair or replacement will be your sole remedy against MYLEX, and MYLEX's only liability to you, for any failure or malfunction of the PRODUCT. The warranty set forth in this paragraph will be void if:

1. The PRODUCT has been installed in an improper manner or in an improper operating environment.

2. The PRODUCT has been modified or repaired by any party other than MYLEX or a MYLEX factory authorized service center.

3. The PRODUCT has been damaged.

Some MYLEX products will have a Warranty Expiration Date label affixed to the product itself. When present, the warranty period will extend through the last day of the month indicated.

This warranty will not apply to, and MYLEX provides no warranty for, any BIOS, software, ROM-based firmware, or any other PRODUCT developed or manufactured by any third party, whether included with this PRODUCT or not. Such warranty or warranties as are provided by third parties, to the extent permitted thereby, shall be made available, and are hereby assigned, by MYLEX to the purchaser of this PRODUCT.

If MYLEX issues a revision to the BIOS, firmware or software included with this PRODUCT within 30 days of your purchase, MYLEX will replace such firmware at no charge except handling fees.

Out of Warranty Service

Mylex products which are ineligible for warranty service may be serviced by MYLEX according to our standard price list, as modified from time to time. A current copy of the standard price list is available from the Technical Support Department.

Limitation of MYLEX Liability

MYLEX's liability arising from the sale, use and disposition of this PRODUCT shall in no event exceed the amount paid to MYLEX for this PRODUCT. MYLEX assumes no liability for damages arising from the use or failure of any MYLEX product. The WARRANY DESCRIBED ABOVE CONSTITUTES THE ONLY WARRANY MADE BY MYLEX. MYLEX EXPRESSLY DISCLAIMS ANY AND ALL OTHER WARRANTIES OF ANY KIND WHATSOEVER, WHETHER EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MERCHANT-ABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY EXPRESSLY EXCLUDED. IN NO EVENT WILL MYLEX BE LIABLE FOR INCIDENTAL, SPECIAL OR CONSEQUEN-TIAL DAMAGES (INCLUDING WITHOUT LIMITATION LOSS OF DATA, USE, OR INCOME), EVEN IF ADVISED OF SUCH DAMAGES IN ADVANCE. Your sole remedies shall be as provided herein.

Returned Merchandise Procedures

If you suspect that there is a defect in the material or workmanship of this PRODUCT, you should contact the person or company from which you purchased it. That person or company may be able to solve the problem and if not, will be able to contact us for technical assistance or repair.

If it is determined that the PRODUCT must be returned to MYLEX for repair or replacement, contact MYLEX's Technical Support Department at 510-608-2400 before it is returned. Each returned item must have a separate Return Merchandise Authorization (RMA) number, provided by MYLEX.

The following rules apply to all returned items:

1. The PRODUCT must be returned either in its original packaging or in other packaging which is appropriate for the PRODUCT and the manner of shipment, and the RMA number must be displayed prominently on the outside of each such package.

2. If a PRODUCT is determined to be ineligible for warranty service, the customer will be notified before any further action is taken with the PRODUCT.

3. MYLEX will not be responsible for any loss or damage to property shipped with the RMA PRODUCT not originally sold by MYLEX (e.g., coprocessor chips, peripheral boards, memory modules, enclosures, power supplies, or any other accessories or attached items).

4. Any item returned to MYLEX without a valid RMA number will be returned to the shipper.

Products shipped to MYLEX must be shipped or mailed at the shipper's risk, freight prepaid, to the address below.

> Mylex Corporation
> 34551 Ardenwood Blvd.
> Fremont, California U.S.A.
> 94555-3607

Mylex will pay for return freight via such carrier as MYLEX shall deem appropriate.

Technical Support

Technical support, to assist you in resolving problems with MYLEX products, is available through MYLEX's Technical Support Department. In the U.S.A., the Technical Support Department can be reached by telephone at (510) 608-2400, by FAX at (510) 745-7715, or by e-mail at support@mylex.com. Current hours of operation, which are subject to change, are from 6:00 a.m. to 6:00 p.m. Pacific Time, Mondays through Fridays, **excluding U.S.A. national holidays.** Many problems can also be solved using the Mylex Web site (http://www.mylex.com), which has a support area available 24 hours a day for interactive technical support.

Included with the shipment of most MYLEX products is a System Problem Report (SPR) form. When contacting the Technical Support Department for assistance with an installation or compatibility problem, we recommend that this form be completed and sent by facsimile or mail to MYLEX. Completion of this form will allow our Technical Support Department to solve most technical problems expeditiously.

Mylex will make reasonable efforts to address compatibility problems which may arise with respect to third party products, but shall not be responsible for the compatibility of its products with the products of any third party. Customers are advised to verify each product's compatibility with their installation before committing to any particular procurement plan.

MYLEX

MOVING DATA ► SMARTER

CORPORATE OFFICE

34551 Ardenwood Boulevard, Fremont, CA 94555-3607
Tel: 510.796.6100
Domestic Sales Fax: 510.745.8016
International Sales Fax: 510.745.7521
www.mylex.com